Supporting Materials
California Education and the Environment Initiative

B

Biology Standard B.8.b.

Biological Diversity: The World's Riches

FINAL DRAFT

California Education and the Environment Initiative

ACKNOWLEDGEMENTS

The EEI Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency
California Integrated Waste Management Board
State Education and Environment Roundtable
National Geographic Society
Heal the Bay
California Department of Education
California State Board of Education
Office of the Secretary of Education
California Natural Resources Agency

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Funding for the development of this curriculum is provided through the generous support of the California Integrated Waste Management Board.
Additional funding is provided by:
California Energy Commission, Department of Conservation, Department of Toxic Substances Control, and State Water Resources Control Board.

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Lesson 3 Responses to Change

Activity Masters

Visual Aids

Lesson 4 Surviving Environmental Change

Activity Masters

Visual Aids

Name: _____

Multiple Choice
Select the best answer and circle the correct letter. (2 points each)

1. Which of the following statements describes a biome?
   a. a specific area containing an identifiable set of interdependent species that interact with each other and the abiotic components found there.
   b. large regions with similar ecosystems characterized by climatic conditions and the type of plant that dominates the area.
   c. the place where an organism lives and meets its needs.
   d. an area set aside to protect resources and natural systems.

2. The geographic extent and biological diversity of ecosystems varies with:
   a. the number of niches available.
   b. latitude.
   c the number of predators in an area.
   d. a and b

3. Which factor(s) affect the capacity of a natural system to recover from human-caused alterations?
   a. the scale of the alteration, whether it is local, regional or national.
   b. the scope of the alteration, whether it is small or large.
   c. the duration of the alteration, how long it lasts.
   d. all of the above

4. High biological diversity:
   a. increases the geographic extent of an ecosystem.
   b. decreases the capacity of a natural system to recover from a naturally occurring event.
   c. increases the likelihood that some species in an ecosystem can survive environmental changes.
   d. only occurs in tropical rainforests and salt marshes.

5. Which human practices influence the biological diversity of different biomes?
   a. logging and mining
   b. farming
   c. urban development
   d. all of the above

Name: _____

Short Answer
Answer each of the following questions in the space provided. (10 points each)

6. Why does biological diversity vary greatly in different ecosystems across the globe?

7. Why is the Sonoran Desert more biologically diverse than the Great Basin Desert?

8. Describe three ways in which large-scale farming can influence species composition and the geographic extent of a rainforest.

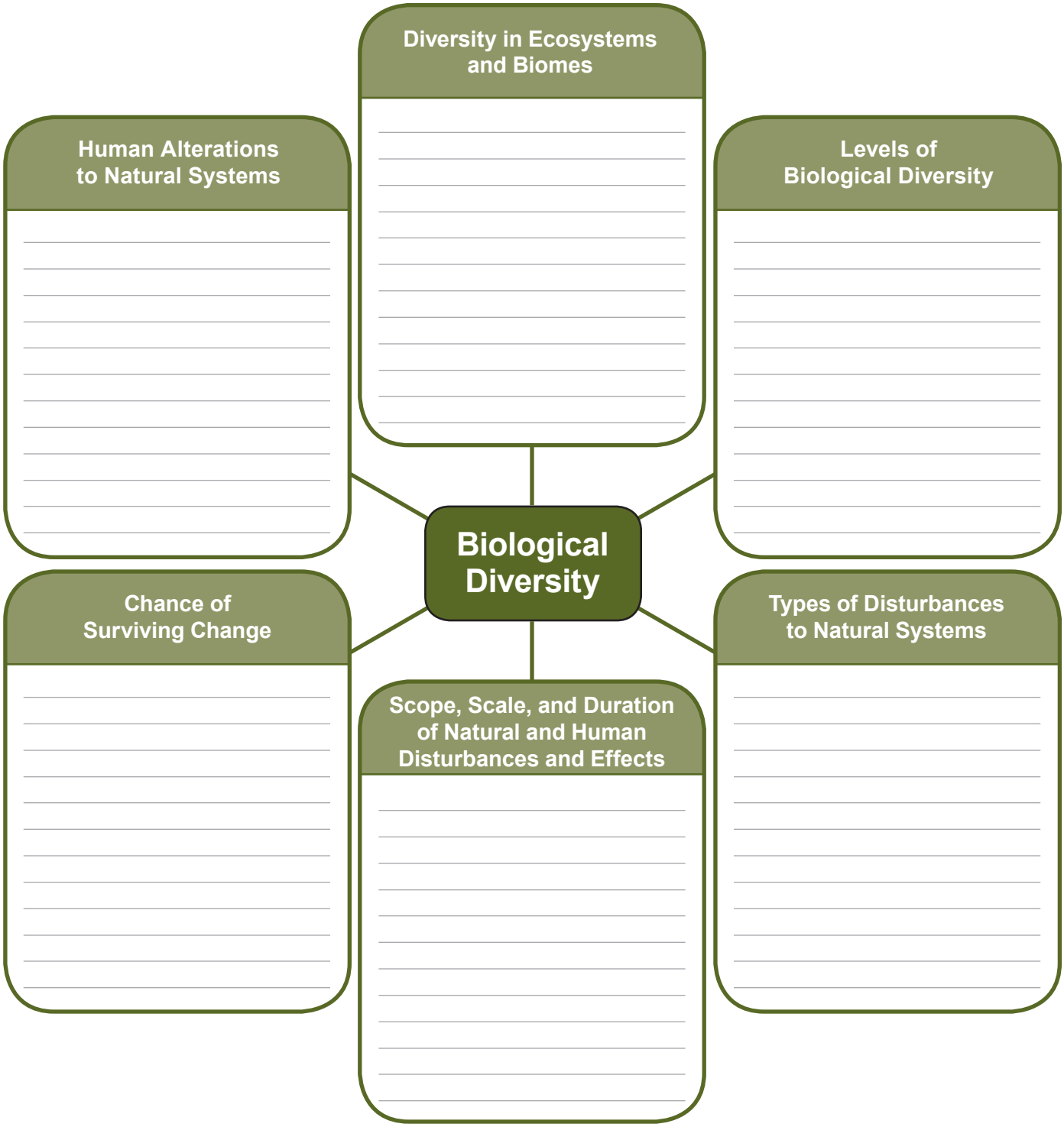
Name: _____

9. The duration, scale, and scope of a disturbance can influence the capacity of an ecosystem to recover and the rate of that recovery. Describe and give at least two examples of this statement.

10. Why does high biological diversity increase the likelihood that some organisms will survive major changes in the environment?

Name: _____

Instructions: Using all of your assignments from the unit, create a concept map that explains the relationship between biological diversity and the topics in each box. State at least two key points under each heading in the spaces provided. Use specific examples from the unit to support your positions. (10 points for each box)



Biodiversity hotspot: A region containing at least 1,500 endemic species of vascular plants that has lost 70 percent of its original habitat, making it a priority for conservation efforts.

Biological diversity (biodiversity): A measure of the number of different species of organisms in a specific area, also used as a general description of species richness, ecosystem complexity, and genetic variation.

Biome: Large regions of Earth's surface that share similar characteristics of climate and vegetation.

Ecosystem: A specific area, such as a kelp forest, that contains a characteristic set of interdependent species that interact with each other and the abiotic components found there.

Ecosystem services: The functions and processes that occur in natural systems, such as pollination, that support or produce ecosystem goods and help sustain human life, economies, and cultures.

Endemic species: A species that is present in and limited to a particular region.

Estuary: A coastal body of water created where the mouth of a river empties into the ocean or a bay and mixes with salt water.

Gene pool: The set of genetic information that collectively defines a species or a population.

Genotype: The genetic makeup of an organism.

Geographic extent: The area through which a species or ecosystem is distributed.

Habitat: The environment in which an organism lives and meets its needs.

Microclimate: A localized climatic condition that differs from the general surroundings due to the local conditions.

Microhabitat: A small and specialized habitat, such as a crevices in caves and undersides of logs, occupied by a species.

Natural system: The interacting components, processes, and cycles within an environment, as well as the interactions among organisms and their environment.

Niche: A description of the how a species functions within an ecosystem such as the types and sizes of foods eaten and the specific habitats occupied.

Primary production: The amount of new organic material that is synthesized through photosynthesis and chemosynthesis, and is available to organisms in an ecosystem.

Range: The entire region in which an organism or ecosystem is naturally found.

Resource extraction: The removal of a natural resource from an area by human practices such as logging and mining.

Territory: The area that an animal defends that contains a nest, den, or mating site and food resources.

Topography: The physical features of the land such as elevation and relative location.

Coastal Wetlands, Treasures of Diversity

Coastal wetlands act as nurseries for ocean fish and help cleanse polluted fresh water as it flows into the ocean. Such features in these transition zones between bodies of water and dry land make these ecosystems some of California's most ecologically significant.

Coastal wetlands include a number of natural communities that share the combination of aquatic, semiaquatic, and terrestrial habitats that result from periodic flooding by tidal waters, rainfall, or runoff.

Coastal wetlands support high levels of biological diversity (biodiversity), meaning they contain many different species in their many habitats. Wet soils and water-tolerant plants abound in wetlands, which are intermittently covered by shallow water. In the coastal zones of California, there are many different types of wetlands. The most common types are estuarine salt marshes and mudflats. An estuary is an area where a freshwater river meets the ocean. Salinity fluctuates in estuaries as ocean tides rise and fall, causing predictable cycles of flooding and flushing. In these areas, plants must be able to tolerate salty water to survive. Other types of coastal wetlands in California include freshwater marshes, bogs, vernal pools, and riparian zones along rivers and streams.

Geologic and climatic processes created our diverse coastal zones. California is situated on the edge of a dynamic continental plate that has been pushed upward over millions of years by the expanding Pacific Plate. Geologists refer to the movement of these plates as continental drift. Ancient rivers flowing into the Pacific Ocean eroded the rising land mass, forming canyons and valleys. The geologic processes of continental drift and erosion, defined the rivers and valleys that we know today. Climatic processes further define these regions. During extended periods of cold weather known as ice ages, sea water evaporates and

Elkhorn Slough, California

Long-billed curlew

is deposited on land in glaciers, causing a decrease in global sea levels. Ice in glaciers reached its greatest volume 18,000 years ago during the most recent glacial period with sea level more than 328 feet (100 meters) below its present level.

The rivers that had cut their way through the rising land to the ocean emptied their fresh water into the ocean. Earth has been slowly warming over the past 18,000 years, with glaciers melting and sea levels reaching their present depth approximately 7,000 years ago. Flooded coastal river valleys created bays, estuaries, and lagoons. Coastal wetlands formed at the fringes of these large water bodies. These areas are now exposed to fresh water from rivers and rain, as well as from tidal influxes of ocean salt water. California has 110 major coastal wetlands, each of which is isolated and biologically diverse. In Northern California, most of the coastal wetlands are estuaries and salt marshes bordering river mouths. The San Francisco Bay estuary is the largest on the west coast of both North and South America. This estuary is also one of the most altered wetland areas in the United States. Historically Southern California supported an extensive network of coastal wetlands at river mouths with salt marshes flanking the region's bays and lagoons. Today these coastal wetlands fall within highly urbanized locations. The wetlands that remain there are small and isolated from other wetlands, but still play an important role in preserving biodiversity.

The coastal salt marsh, a specific type of coastal wetland, is one of the most productive ecosystems in the world. Coastal salt marsh primary productivity—the rate at which energy accumulates in an ecosystem as a result of photosynthesis by plants—rivals that of tropical rainforests. A variety of animals can consume this energy accumulated in plants, forming a diverse and intricate food web. Marsh plants and phytoplankton that sequester energy from the Sun form the base of a salt marsh's food web. Abundant sunlight in shallow marsh water allows these organisms to photosynthesize at a high rate. Shrimp, clams, oysters, and some fish eat phytoplankton and zooplankton. Larger fish, birds, and wetland mammals in turn eat these animals. When animals die, decomposers such as bacteria and fungi break them down and convert them

into nutrient-rich detritus. Waste products from animals add more nutrients to the water and soil. Tides, freshwater flows, and the burrowing action of bottom-dwelling animals circulate the nutrients for use by new organisms. Flowing rivers also carry some nutrients to the ocean, while animals that feed in the marsh and then travel to upland habitats export still other nutrients to upland ecosystems.

There are many diverse habitats in a salt marsh ecosystem. Combined with high primary productivity, this habitat diversity gives rise to astonishing biological diversity. Hundreds of species are adapted to take advantage of different opportunities within this ecosystem. Birds such as curlews and godwits have long legs for wading and long beaks for probing for invertebrates in the mud. The rare light-footed clapper rail makes a platform nest of cordgrass in the lower reaches of the marsh, while the equally rare Belding's savannah sparrow nests in the pickleweed in the upper marsh. Migratory birds use salt marshes for resting and feeding stops during their long journey along a migratory route known as the Pacific Flyway. Marsh hawks fly low, hovering in search of rabbits and other small vertebrates that live in the vegetation along the marsh's fringe. Eelgrass beds provide nurseries for many species of juvenile fish, such as the California killifish, pipefish, bay goby, and striped bass. Upland species such as the raccoon, fox, and coyote follow the waterline, hunting and foraging.

Salt Grass

Many organisms have adaptations that allow them to cope with the marsh's constantly changing and often extreme environment characterized by high salt concentrations, periodic flooding and drying, and low oxygen levels in waterlogged soils. For example, saltgrass has adapted to excrete salt before it builds up to toxic levels. Many wetland plants contain air spaces in their roots and stems that allow oxygen to diffuse from the tops of plants to the roots. This adaptation allows them to survive in the anaerobic wetland soils. Fiddler crabs are active during low tides when water recedes from mudflats. Since they breathe air, these crabs hide in burrows when the tides rise. There, a pocket of air supplies them with oxygen.

People rely on many ecosystem goods and ecosystem services provided by coastal wetlands. Marsh plants, such as eelgrass, decrease the speed of currents, absorb wave action, and capture sediments, slowing erosion and protecting shorelines. Coastal wetlands can also store large quantities of water, helping to control flooding. Wetlands also improve

water quality. Water flowing into a wetland often contains pollutants from a watershed's upper reaches. As currents slow, sediments settle out. Pollutants in those sediments sink into the wetland floor, where they are buried in layers. To varying degrees, wetland plants take up pollutants, while microorganisms in their tissue and roots break other pollutants down. By acting as natural water filters, wetlands decrease levels of pollution that drains into bays and oceans. Wetlands also support fisheries by providing critical habitat and nurseries for commercially important species.

Before the 1970s, many people viewed wetlands as "wasted land." Builders drained, filled, and developed these "swamplands" for housing or commercial development. Industrial pollutants contaminated many remaining wetlands and road construction blocked critical tidal flow, degrading coastal ecosystems. Additional wetlands have been shrunk or eliminated by the dredging of port channels and filling of estuaries for boat facilities. Tide gates and flood control projects change the natural flow of salt water and fresh water. Today state and federal laws protect the remaining coastal wetlands in California, with further development tightly regulated. But coastal wetlands still suffer from the legacy of past development—all of the activities described above affect the health and functioning of these systems.

Roads over Sweetwater Marsh, San Diego, California

Since the 1850's, 90 percent of California's original coastal wetland acreage has disappeared. The remaining areas represent a critical part of California's biological diversity. As people seek to protect them, they also seek to protect the state's high levels of biological diversity and the goods and services these ecosystems provide. In turn, protectors of wetlands enhance quality of life for humans, today and in the future.

Name: _____

Answer the following questions. (5 points each)

1. What did you observe about the diversity of California's ecosystems as you looked at the Biological Diversity wall map?

2. Why is California considered a biodiversity hotspot?

3. What have you observed about the distribution of biomes around the world?

4. As you compare the number of biomes with the number of vegetation types and ecosystems in California, what can you conclude about biological diversity in California?

5. According to the **Diversity of Life** map, what biome can be found in North America, South America, Africa, Asia, and Australia?

Name: _____

6. What characteristics common to many of California's ecosystems lead to the state's high biological diversity?

_____

_____

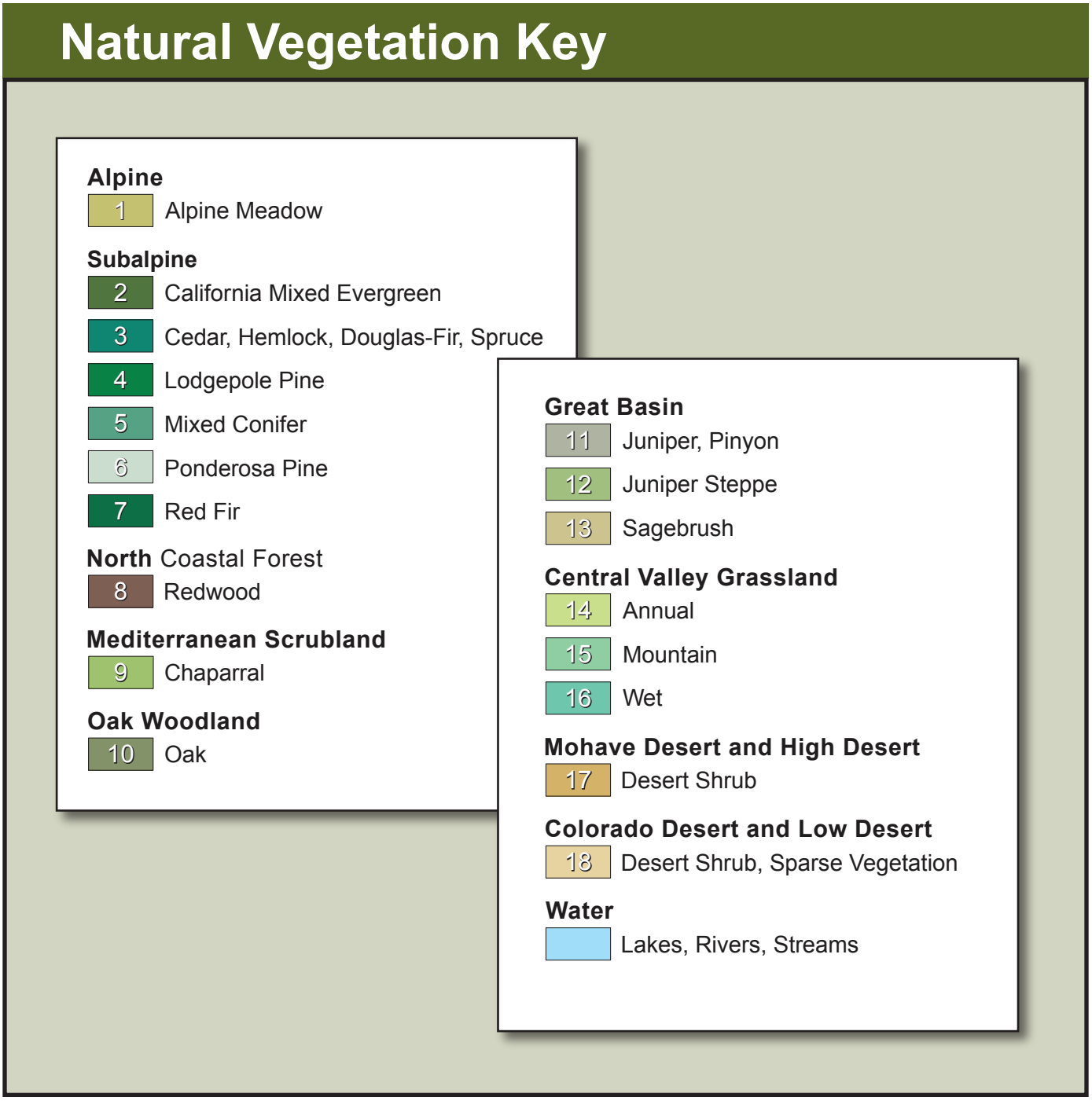
_____

_____

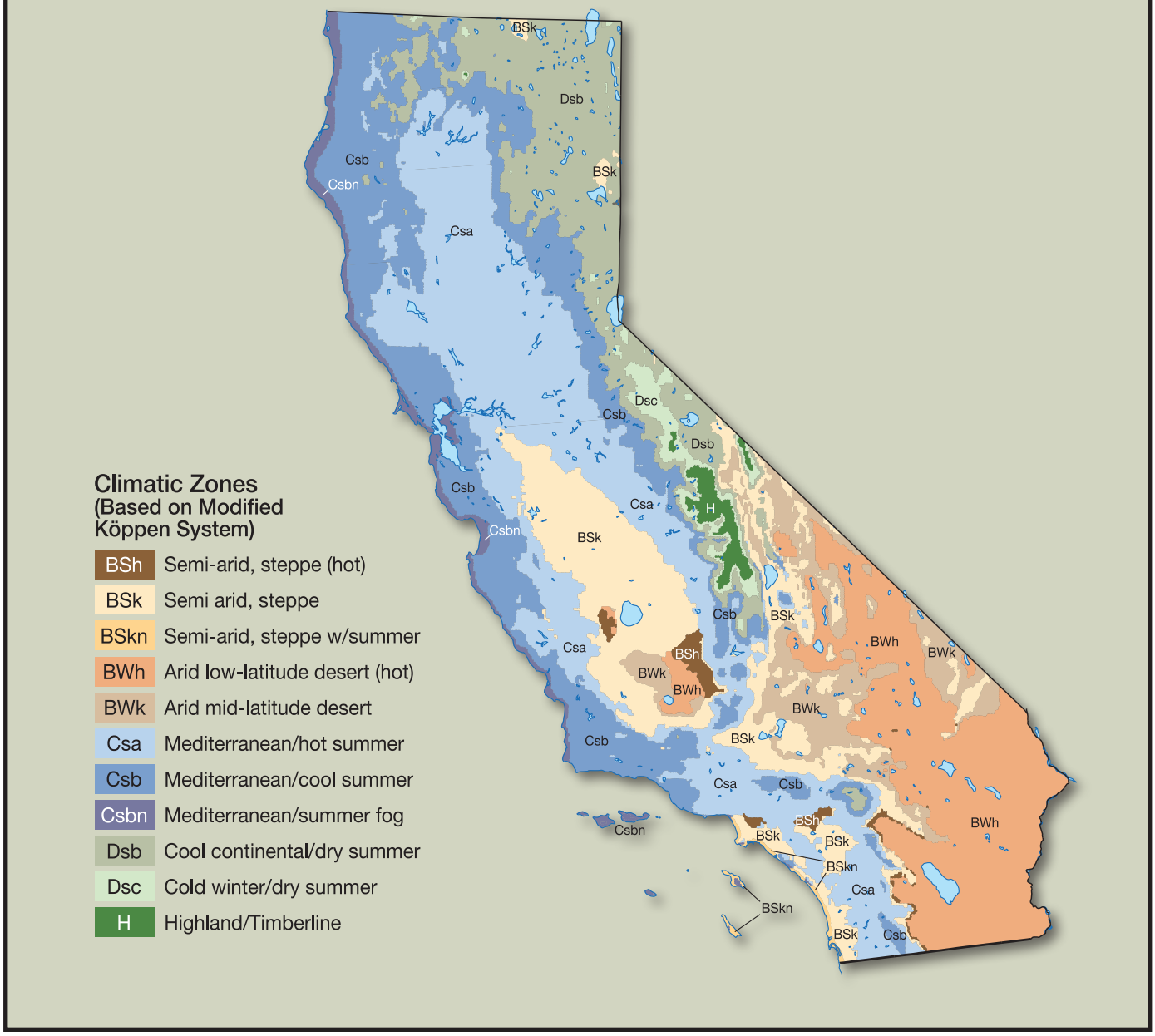
_____

_____

Natural Vegetation Key



California Climatic Zones



California Coastal Salt Marshes

Biodiversity and Coastal Wetlands

1. **What is a coastal wetland?**

2. **What are some abiotic and biotic characteristics of California's coastal wetlands?**

3. **What is primary productivity?**

4. **Why do California's coastal wetlands have high primary productivity?**

5. **How does primary productivity support species diversity?**

6. **Why are California's coastal wetlands high in biodiversity?**

Great Basin Desert

The Great Basin Desert is the largest and northernmost desert in the United States. This arid region covers approximately 190,000 square miles centered in Nevada and touching parts of California, Utah, Idaho, and Oregon. This desert sits in the rainshadow of the Sierra Nevada mountain range of eastern California. Prevailing winds from the Pacific Ocean rise to go over the Sierra Nevada. The air cools and most of its moisture falls as rain on the western slopes of the range. By the time the air reaches the far side of the mountains, it is dry and absorbs moisture from its surroundings. This drying effect creates the Great Basin Desert.

This desert sits at a high altitude. The lowest basins in the Great Basin Desert are higher than 3,000 feet in elevation; some peaks reach 12,000 feet. Average desert elevations range from 4,000 to 6,500 feet. Because of its northerly latitude and relatively high elevations, the Great Basin Desert is considered a "cold" desert, the only one in the United States. Temperatures are cooler than in "hot" deserts and in winter, there is usually snow. Precipitation averages 7 to 12 inches per year and is relatively evenly distributed throughout the year.

Vegetation is similar throughout this desert; variation in plant life is low compared to other deserts. Low-growing shrubs are the most common form of vegetation. Few cacti grow here. A single species of bush—often sagebrush—typically dominates the landscape for miles. Great Basin animals include the bighorn sheep, jackrabbit, pocket mouse, pronghorn antelope, sage thrasher, golden eagle, and the western diamondback rattlesnake.

Great Basin Desert, Nevada

Mojave Desert

The Mojave Desert is situated between the Great Basin Desert to the north and the Sonoran Desert to the south. It is 25,000 square miles, centered in southeastern California and reaching into Nevada, Arizona, and Utah.

While typical elevation in the Mojave varies from 3,000 to 6,000 feet, this desert has its extremes. Telescope Peak is located at 11,049 feet and Badwater—the lowest point in the United States—is located at 282 feet below sea level.

Both latitude and altitude affect the climate, which experiences variations in temperature and rainfall. The Mojave is relatively hot year round, but there are four distinct seasons. During winter storms temperatures can be lower than 20º F (-6.7º C, but they reach 80º F (26.7º C) between storms. It is often cloudy and windy in winter and it occasionally snows. Spring rains are infrequent but widespread, with temperatures typically falling above 90º F (32.2º C).

Mojave Desert, California

Summer sees extreme heat and thunderstorms. Temperatures reach 120º F (48.9º C on valley floors. October is normally the driest month of the year; rain is infrequent in fall, and temperatures average 70º F (21.1º C) to 90º F (32.2º C). The Mojave generally receives less than 10 inches of rain each year.

The Mojave is geographically varied, made up of mountains and valleys. It is home to more than 2,000 species of plants, which are fairly evenly distributed throughout the region. Lowland shrubs such as creosote and sagebrush are common, as are a few species of cacti. One of the most characteristic plants of the Mojave Desert is the Joshua tree. In the Mojave, plants and animals must be adapted to a long dry season and relatively cold winters.

Sonoran Desert

The Sonoran Desert is an arid region in southwestern Arizona and southeastern California. The 120,000 square mile desert also covers most of Baja California and the western half of the state of Sonora, Mexico.

The Sonoran Desert is the hottest and wettest desert in North America. It is also the country's southernmost desert and has the lowest average elevation. Storms come in from the Pacific during winter; summer sees a somewhat rainy monsoon season. With its two-season rainfall pattern, the Sonoran Desert is the wettest desert in the world. Some areas receive as much as 25 inches of rainfall annually. Summer temperatures average about 110º F (43.3º C) during the day and between 40–50º F (4–10º C) during the night. Winters are relatively warm.

Reliable sources of water in this habitat throughout the year allow for a wider variety of plants to grow in the Sonoran than other deserts. Winter storms give way to rich blankets of spring wildflowers. The Sonoran is the only place in the world where the towering saguaro cactus grows wild. Many other species of cactus are found here, too. Desert streams here are sometimes lined with trees including ash, walnut, cottonwood, and willow. An understory of woody shrubs occurs below the trees. The relatively wide variety of plant communities in this desert feed and house many animals, including many types of mammals, reptiles, and birds.

Sonoran Desert, Arizona

Name: _____

Part 1

Describe and compare the three deserts by completing the following chart. (1 point per box)

	Great Basin	Mojave	Sonoran
Precipitation (Amount and Patterns)			
Climate (Degrees and Patterns)			
Location (Elevation and Latitude)			
Plants and Animals (Variety and Distribution)			

Name: _____

Part 2

As a group, use the chart to compare the three deserts and answer the following questions.

1. Can deserts have varying levels of biological diversity? Explain, using the Sonoran, Mojave, and Great Basin Deserts as examples. (3 points)

2. Which of these three deserts has the highest biological diversity? Explain your answer. (2 points)

3. What factors lead to higher levels of biological diversity in a desert ecosystem? (3 points)

Name: _____

Each grid below represents the same size area and each box in the grid represents the same size section of land. The top grid represents a desert biome and the bottom one represents a tropical rainforest biome. Each letter in the boxes represents a different species living in an ecosystem; the grid shows where different species live in each ecosystem.

Desert

A, B, C, D, E, F, G	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J
A, B, C, D, E, F, G	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J
A, B, C, D, E, F, G	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J
A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	D, E, F, G, H, I, J
A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	D, E, F, G, H, I, J	D, E, F, G, H, I, J

Tropical Rainforest

A, B, C, D, E, F, G, H, I, J, K	A, C, D, E, F, G, H, I, J, K, L, M, N	E, F, G, H, I, J, K, L, M, N, O, P, Q, R	A, C, D, F, H, I, K	A, F, G, I, L
I, J, K	C, I, J, K, L, M, O, Q	F, G, H, I, J, L, M, N, O, P, Q, R, S, T	D, F, H, I, S, T	A, G, H, K, S
I, J, K, L	I, J, K, L, M, O, P, Q, R, S, T, U, V, X	D, I, P, R, S	D, F, I, K	I, K, P, T, Y
A, B, C, D, E, F, I	A, B, C, D, E, F, G, I	A, D, G, I, J, K, M, R	I, X, Y, Z	K, X, Y, Z
A, B, C, D, I	A, B, C	A, D, G	W, X, Z	K, X, Z

Name: _____

1. Which biome has greater biodiversity?

2. Which species in the rainforest has the greatest geographic extent (broadest distribution)? Explain your reasoning.

3. Which species has the smallest geographic extent (distribution)? Which biome does it live in? Explain your reasoning.

4. How does the species distribution differ between the two ecosystems?

5. Why does the species distribution differ between the two ecosystems?

6. What can you conclude about the biological diversity of ecosystems within different biomes? (Be prepared to explain your answer to the rest of the class.)

Name: _____

The redwood forest is an ecosystem in the temperate coniferous forest biome.

Redwood Forest				
A, B, C, D, E, F, G	A, B, C, D, E, F, G, H, I, J	A, B, C, D, E, F, G, H, I, J	C, D, E, F, G, H, I, J, K, L, M	C, D, E, F, G, J, K, L, M, N
A, B, C, D, E, F, G, H	A, B, C, D, E, H	A, B, C, D, H, I, J, K, M	A, B, C, D, E, F, G, H, I, J	C, D, E, F, G, J, K, L, M, N
A, B, C, D, E, F, G	A, B, C, D, E	A, B, C, D, H, I, J, K, M	A, B, C, D, H, I, J, K, L, M	C, D, E, F, G, J, K, L, M, N
B, C, D, E, H, P	A, B, C, D, E, H, I	A, B, C, D, E, F, G, H, I, J	C, D, E, F, G, J, K, L, M, N	C, D, E, F, G, J, K, L, M, N
B, C, D, E, F, G, H, I, J, P	A, B, C, D, E, F, G, H, I, J, M, O, P	C, D, E, F, G, J, K, L, M, O	C, D, E, F, G, J, K, L, M	C, D, E, F, G, J, K, L

1. Compare the species distribution in the redwood forest to that of the desert and tropical rainforest biomes. List the ecosystems in order by level of biological diversity. Explain how you decided on that order. (3 points)

   Lowest: _____

   Midlevel: _____

   Highest: _____

Name: _____

2. Why are tropical rainforest ecosystems considered to have high levels of biological diversity? (3 points)

3. Why do the geographic extent and biological diversity of ecosystems vary in different biomes? (4 points)

Tropical Rainforest

Mojave Desert

Sonoran Desert

Name: _____

Complete the chart during class discussion.

Natural Event or Human Practice	Description	Effects on Natural System	Effects on Species Composition	Effects on Local Geographical Extent of Rainforest
Tropical Storm				
Drought				
Farming				

Name: _____

Natural Event or Human Practice	Description	Effects on Natural System	Effects on Species Composition	Effects on Local Geographical Extent of Rainforest
Logging				
Mining				

Tropical Storms and Hurricanes

Tropical Storms and Hurricanes

- bring heavy rains and wind speeds of between 39 and 73 mph; they reach hurricane status if wind speeds exceed 74 mph.
- increase the mortality rate of trees to 40% in highly impacted areas, versus the 2% to 5% of rainforest trees that die of natural causes in normal years.
- destroy habitats, especially microhabitats, causing species to die or move away.
- sometimes bring permanent loss of habitat and species, depending on the severity of the storm and the extent of damage.

Case Study: El Yunque National Caribbean Rain Forest, Puerto Rico.

- 28,000-acre tropical rainforest in the Sierra de Luquillo Mountains in eastern Puerto Rico.
- designated a Biosphere Reserve in 1976.
- home to endangered and endemic species: over 225 species of plants (23 are endemic); over 70 species of birds; diverse reptiles, amphibians and invertebrates. Historically there were 22 mammal species here, but now the only mammals are bats (of 11 varieties).
- in 1989 Hurricane Hugo crossed eastern Puerto Rico and caused severe damage to the El Yunque rainforest; meteorologists estimate that storms of Hurricane Hugo's magnitude pass over this part of the El Yunque rainforest an average of once every 50 to 60 years.
- hurricanes increase the number of severely damaged trees, but the resulting breaks in the canopy allow light to reach the forest floor and can increase the growth of remaining plants.

Recovery

- The length of recovery depends on the severity of the storm. Scientists believe that full recovery from Hurricane Hugo damage could take at least 250 years.

Tropical Storms and Hurricanes

Drought

Drought

- long periods (months or years) when a region receives less water than normal.
- results from a reduction in either rainfall or water vapor (rainfall is related to water vapor in the atmosphere).
- weakens natural systems, making them more susceptible to fire.
- weakens the forest canopy and affects leaf litter decomposition, which is essential to nutrient cycling and plant growth.
- changes microclimates and affect microhabitats.
- brings a decrease in the number and diversity of plant and animal species.

Drought, Fire, and El Niño

- El Niño, a major warming of equatorial waters in the Pacific Ocean, occurs every three to five years in some regions it causes wetter conditions and in others, drought conditions.
- during El Niño years, rainforests are more susceptible to large fires, which can have negative long-term effects on forest composition, structure, regeneration, and recovery.
- fires can occur naturally and serve an important function in maintaining the health of certain ecosystems.
- fires in rainforests are relatively rare where human activity is very limited.
- in forests affected by fire, ground vegetation can burn and clear the forest floor, which can promote growth of new plants.
- between 1997 and 1998 millions of hectares of rainforest were destroyed around the world during an intense El Niño-related drought; the drought affected rainforests in Brazil, cloud forests in Chiapas, Mexico, and lowland rainforests in Borneo.

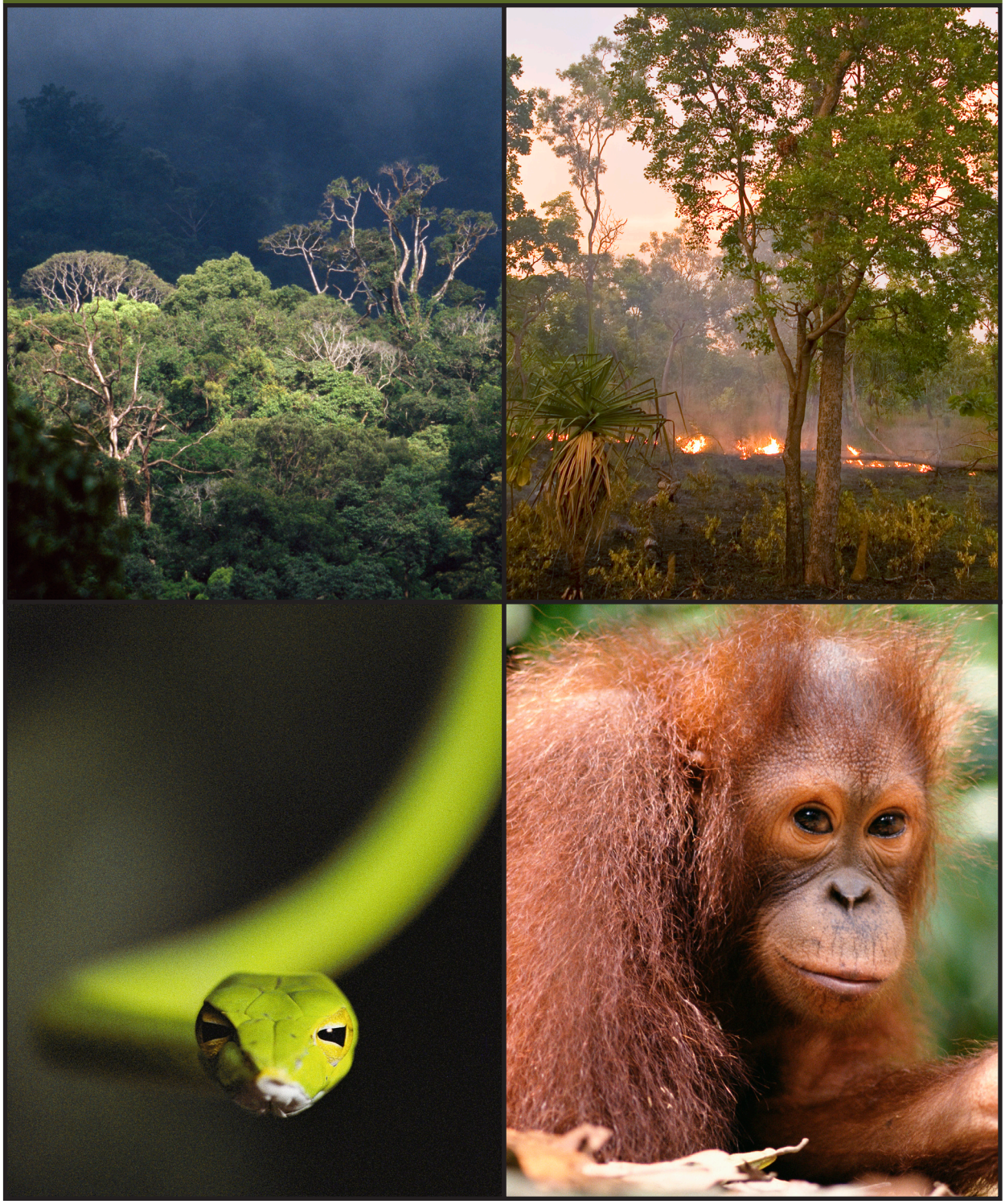
Case Study: Lowland Tropical Rainforests of Borneo

- Borneo is third largest island in the world; was once covered with dense rainforests.
- island is part of three countries: Malaysia, Indonesia, and Brunei.
- Malaysian part of Borneo includes the states of Sabah and Sarawak.
- Indonesian part of Borneo includes the states of West Kalimantan, Central Kalimantan, South Kalimantan, and East Kalimantan.
- Brunei is an independent nation that includes the rest of the island.
- Borneo is home to 15,000 plant species (240 different species of trees can grow in one hectare there); 222 mammal species (including orangutans); over 350 species of birds; and many reptiles, amphibians, and freshwater fish.
- many species there have overlapping ranges.

Recovery

- The length of time required for recovery from drought depends on the intensity of the drought, its duration, and the quantity of precipitation the area receives as the drought ends.

Drought



Logging

Different Types of Logging

Logging by Clear-Cutting

- results in the removal of all species of trees from a given area.
- is often the chosen approach because in rainforests no one species dominates the ecosystem and valuable timber trees are widely spaced.
- is a practice that requires road construction and often results in the settlement of an area by humans, in turn encouraging other human practices and activities.
- results in the elimination of wildlife species due to loss of habitat.

Selective Logging

- involves the felling of specific trees of significant value.
- during this process only selected trees are cut, but the method also brings down other trees, vines, and epiphytes.
- opens the canopy, which can take hundreds of years to recover.
- affects decomposition of leaf litter and nutrient cycling.
- requires road construction, a destructive activity, for transportation of timber.
- disturbs soil and causes erosion.
- results in the runoff of forest soils into rivers and streams and causes siltation.
- leaves behind remnants of trees and underbrush (called “slash”), which are dry and susceptible to burning.
- has indirect effects such as stress to and loss of habitats, territory, shelter, and food for wildlife.

Byproducts from Deforestation of Rainforest Lands

- soil erosion and chemicals in soil, water, and air.
- loss of habitat.
- loss of species.

Recovery

- a logged ecosystem never returns to its original condition; a recovered forest is not diverse.
- little, if any, industrial logging is sustainable over time, whether clear-cutting or selective logging practices are used.
- recovered forest could be used to grow sustainable forestry products and for low-intensity logging and agriculture.
- restoration of some native species is possible; this process is most successful where remnants of original forest remain and there are few human pressures.

Logging

Farming

Farming

- brings the clearing of both undisturbed and logged rainforest for crops and grazing.
- often follows logging, which requires that roads to an area be built for transportation of timber (the roads open the new areas to agriculture).
- consists of either commercial agriculture, subsistence farming, or shift cultivation.

Case Study: Lowland Tropical Rainforests of Borneo

- oil palms produce more oil per hectare than any other oilseed.
- over 7 million hectares of Borneo rainforest are projected to be converted to oil palm plantations by 2011.

Different Types of Farming

Commercial Agriculture

- often occurs after large areas are clear-cut and then burnt to clear brush and release nutrients into the soil.
- often uses chemicals for fertilization and pest control. The chemicals directly affect soil, water, and air quality.
- indirectly causes stress and loss of habitats, and food for wildlife.

Subsistence Farming

- involves the cultivation of a small piece of land by a farmer to regularly produce enough crops for his or her family's survival.
- involves the growth of a diversity of crops, a practice that does not deplete soil as readily as the growth of a single crop.
- sometimes involves the use of the slash-and-burn technique to clear small areas.

Shift Cultivation

- involves setting up small-scale farming operations in disturbed areas following roads made for logging and mining. After the lands become infertile, the farmers move on to new areas.
- people do not move into undisturbed rain forest; rather, they follow other developments like roads and mines.
- results in nutrient poor soils.
- farmers may use chemical fertilizers to improve crop yield.

Byproducts from Agricultural Uses of Rainforest Lands

- soil erosion.
- introduction of chemicals into soil, water, and air.
- loss of habitat.
- loss of species.

Recovery

- habitat destruction permanently reduces local geographic extent of rainforest species.
- ecosystem never recovers to its original condition.
- sustainable commercial agriculture depends on management techniques, allowing soils to remain fallow for periods of time and reducing the use of chemicals.

Farming

Mining

Different Types of Mining

Mining via Open Pits

- in the 1970s, mining companies began moving into rainforests and developing large-scale mining operations for gold, diamonds, copper, and other minerals.
- large open pit gold mines destroy large surface areas and remove minerals from the ground.
- miners use toxic chemicals, such as cyanide, to separate gold from ore
- tailings ponds created for iron ore waste contains cyanide that leaches into groundwater.
- extraction processes require the clearing of forest for mines, access roads, and other mining operations.
- mining requires heavy water consumption.
- animal species die or move away during mining and plant life is destroyed.
- mining pollutes air, land, and water.

Small-Scale Mining

- almost all small-scale gold mining uses large heavy equipment.
- miners are not formally trained in mining techniques and have little oversight from the government.
- Small-scale gold mining uses mercury to separate gold from ore; mercury contaminates air, soil, and water and accumulates in fish.

Byproducts from Mining in the Rainforest

- soil erosion.
- chemicals that enter soil, water, and air.
- loss of habitat.
- loss of species.

Recovery

- abandoned small-scale gold mining sites can take several decades to recover due to disturbed soil and hydrology. Although these sites can recover somewhat, they never return to their original condition.

Mining

Name: _____

Part 1

Complete the chart during class discussion.

Natural Event/ Human Practice	**Scope** (Local, regional, or national)	**Scale** Small scale (tens to hundreds of acres), large scale (thousands of acres)	**Duration** Length of time (short term, ongoing, indefinite)	**Byproducts or Effects**	**Recovery or Capacity to Adjust**
Tropical Storm					
Drought					

Name: _____

Natural Event/ Human Practice	**Scope** (Local, regional, or national)	**Scale** Small scale (tens to hundreds of acres), large scale (thousands of acres)	**Duration** Length of time (short term, ongoing, indefinite)	**Byproducts or Effects**	**Recovery or Capacity to Adjust**
Farming					
Logging					
Mining					

Name: _____

Part 2

Summary Questions

Use examples from the handout **Events and Practices that Affect Rainforest Ecosystems** and your responses on the chart on **Capacity to Adjust** to answer the following questions.

1. How do natural events and human practices influence the local geographic extent of rainforest ecosystems? (5 points)

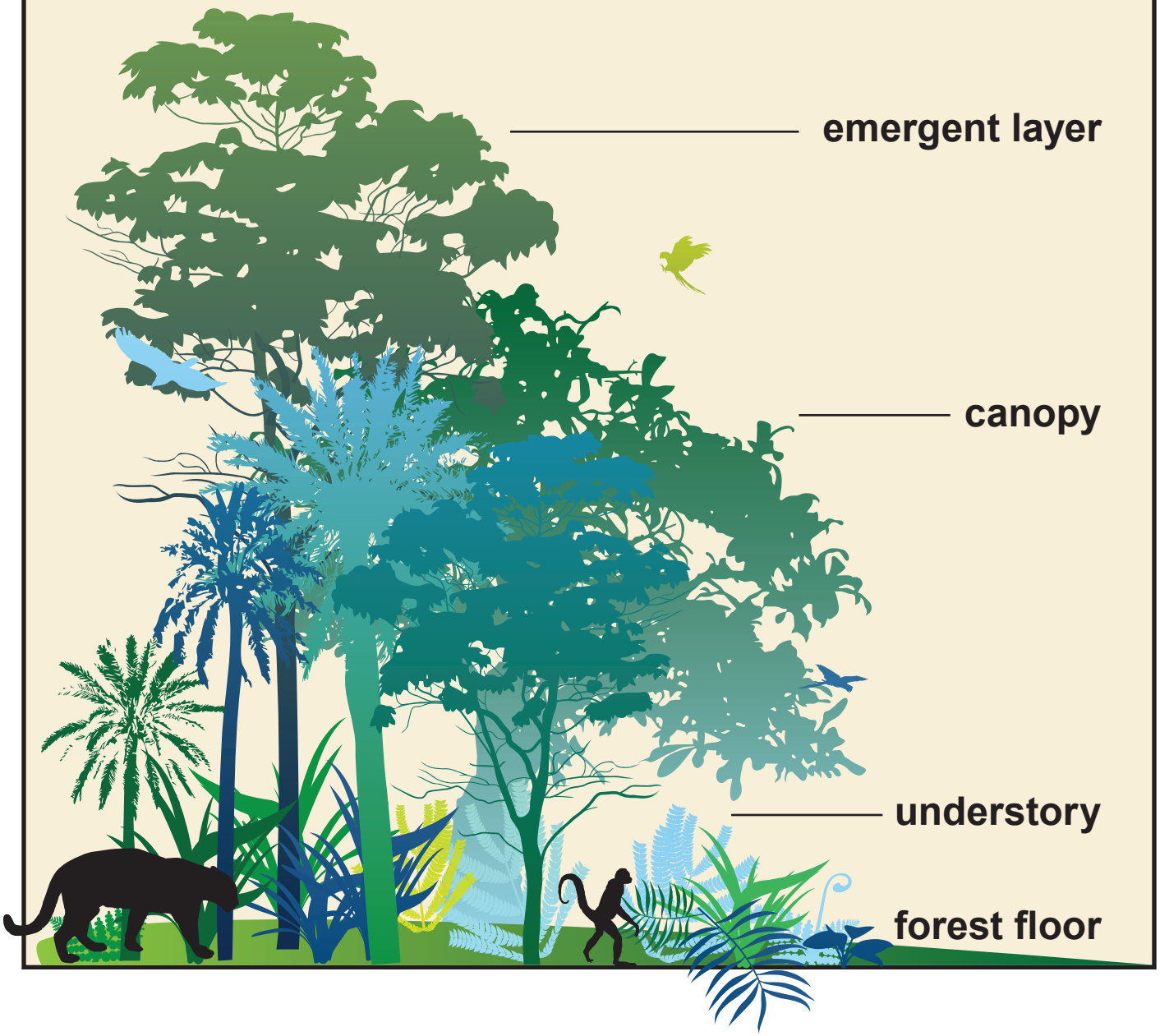
2. How do natural events and human practices affect the species composition of rainforests? (5 points)

Name: _____

3. Describe one natural event and one human practice discussed in this lesson. Explain which of the two affords the rainforest ecosystem a better chance of recovery. (10 points)

Rainforests

Layers of the Tropical Rainforest



Tank Bromeliad

Events and Practices that Affect Rainforest Ecosystems

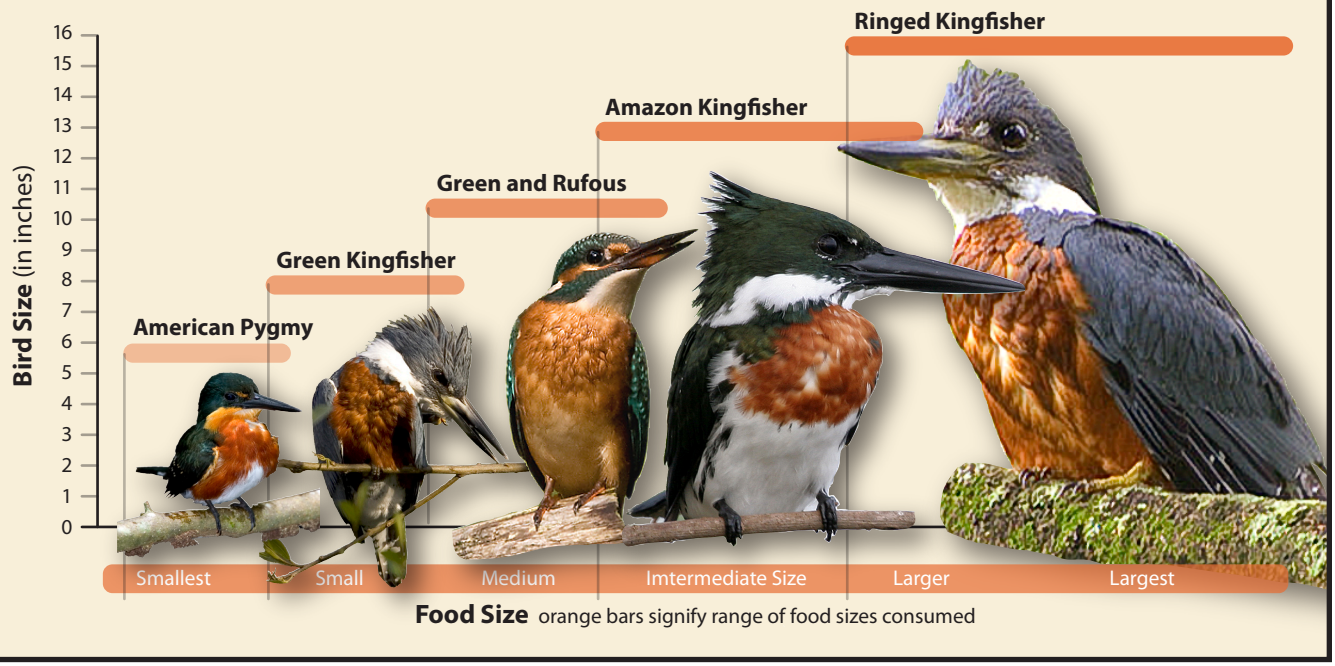
Natural Event or Human Practice	Description	Effects on Natural System	Effects on Species Composition	Effects on Local Geographical Extent of Rainforest
Tropical Storm				
Drought				
Farming				
Logging				
Mining				

Capacity to Adjust

Natural Event/ Human Practice	Scope (Local, regional, or national)	Scale Small scale (tens to hundreds of acres), large scale (thousands of acres)	Duration Length of time (short term, ongoing, indefinite)	Byproducts or Effects	Recovery or Capacity to Adjust
Tropical Storm					
Drought					
Farming					
Logging					
Mining					

Name: _____

Kingfishers of Panama



Answer the questions below. (5 points each)

1. What is the correlation between the size of a kingfisher and the size of fish it eats?

   _____

   _____

2. What types of human activity could cause a major environmental change that could affect kingfishers?

   _____

   _____

3. A human practice has eliminated all fish of a particular size needed by the Amazon kingfisher.
   a. What happens to this species of kingfisher?

      _____

   b. How many kingfisher species remain?

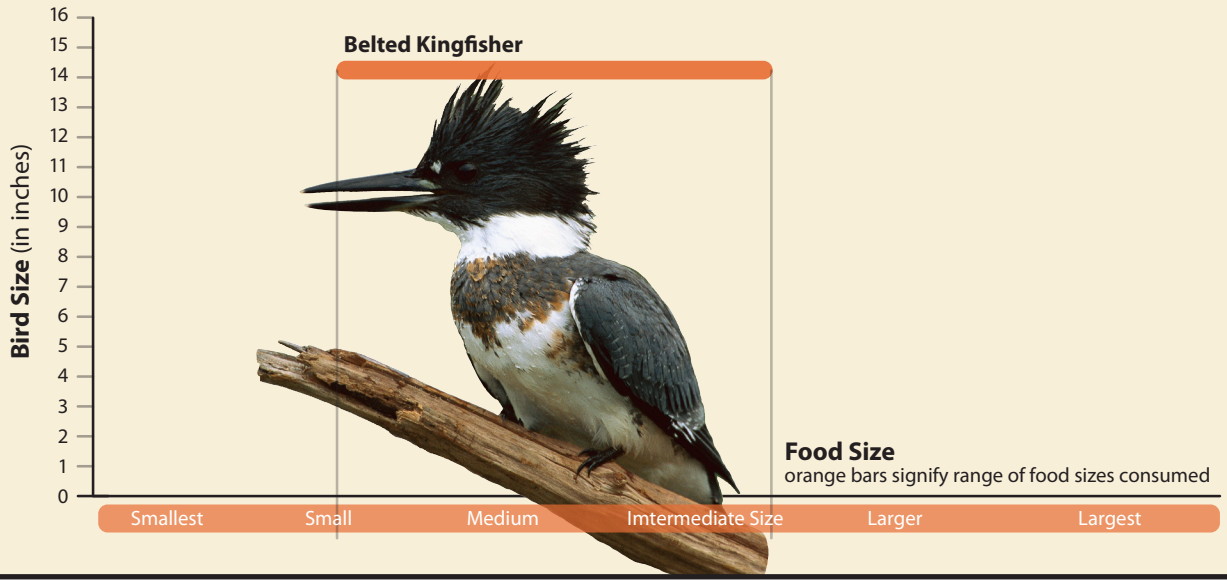
      _____

   c. What happens to the overall range of characteristics and adaptations (gene pool) of kingfishers in this ecosystem?

      _____

Name: _____

Belted Kingfisher



4. A human practice has eliminated all fish of the size needed by the belted kingfisher.
   a. What happens to this species of kingfisher?

      _____

   b. How many species of kingfisher remain in this ecosystem? _____

   c. What happens to the gene pool of kingfishers in this ecosystem? _____

5. In which natural system, the rainforest of Panama or the North American woodland, is there a better chance that some species of kingfishers will survive major changes in the environment? _____

   Why?

   _____

   _____

   _____

Summary Question

6. Which global biomes are being affected by human-caused practices? _____

   Why?

   _____

   _____

   _____

Kingfisher Background Information

There are 90 species of kingfishers in the world. The species are divided into three groups: tree, river, and water kingfishers. All are small- to medium-sized, colorful birds with short necks, relatively large heads, and long, thick bills. They live in all regions of the world, except the polar regions and some ocean islands. They live in forested or open woodlands, often near water, and in aquatic habitats including seashores, mangrove swamps, lakes, rivers, and streams. One species lives in desert scrub. Most kingfisher species nest in horizontal tunnels in earthen banks. Some nest in tree cavities or other openings.

This lesson focuses on six New World species from the water kingfisher group. These kingfishers are fish-eaters. Although all six species have long, thick bills, the bills vary in shape according to the eating habits of each species. Different sized bills enable the kingfishers to eat different sized fish, thus reducing competition among kingfisher species (and between kingfishers and other species) in the same general habitat.

American Pygmy Kingfisher
Chloroceryle aenea

Size: 5 inches, 0.63 ounces; short tail and long bill

Range: Southern Mexico to northern Bolivia and southern Brazil

Habitat: This tiny kingfisher lives in dense forests and mangroves along small streams or rivers with heavily vegetated banks. It usually nests in horizontal tunnels in river banks.

Food: Small fish or tadpoles

Green Kingfisher
Chloroceryle americana

Size: 7–8 inches, 0.95 ounces; short tail and long bill

Range: Extreme southwestern United Stases to northern Chile and central Argentina

Habitat: This small kingfisher lives in forests or mangroves along small streams.

Food: Fish and aquatic insects

Green-and-rufous Kingfisher
Chloroceryle inda

Size: 8–9 inches, 2.11 ounces; short tail and long bill

Range: Nicaragua to northern Bolivia and central Brazil

Habitat: This small kingfisher lives near rivers and streams in dense lowland forests and mangroves.

Food: Fish

Amazon Kingfisher
Chloroceryle amazona

Size: 11–12 inches, 3.88 ounces; short tail and long bill

Range: Mexico to central Argentina

Habitat: This medium-sized kingfisher lives near rivers and streams.

Food: Fish

Belted Kingfisher
Megaceryle alcyon

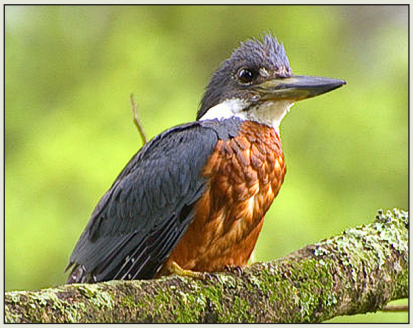
Size: 12–13 inches, 5–6 ounces; short tail and long bill

Range: North America to Panama

Habitat: This kingfisher lives near streams, lakes, bays, and coasts.

Food: Fish

Ringed Kingfisher
Megaceryle torquata



Size: 15–16 inches, 11.1 ounces; short tail and long bill

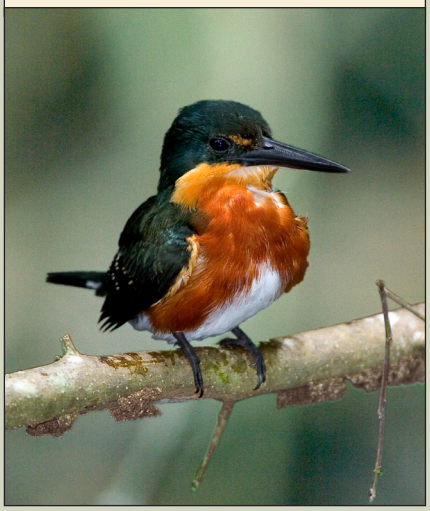
Range: Southern Texas and Mexico to Tierra del Fuego

Habitat: This large kingfisher lives near rivers and streams.

Food: Fish

Kingfishers of Panama

American Pygmy Kingfisher
Chloroceryle aenea

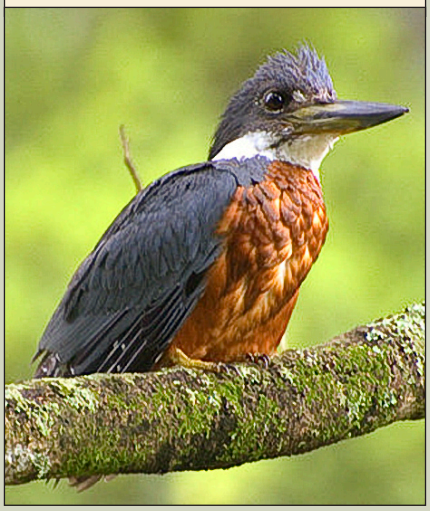


Green Kingfisher
Chloroceryle americana

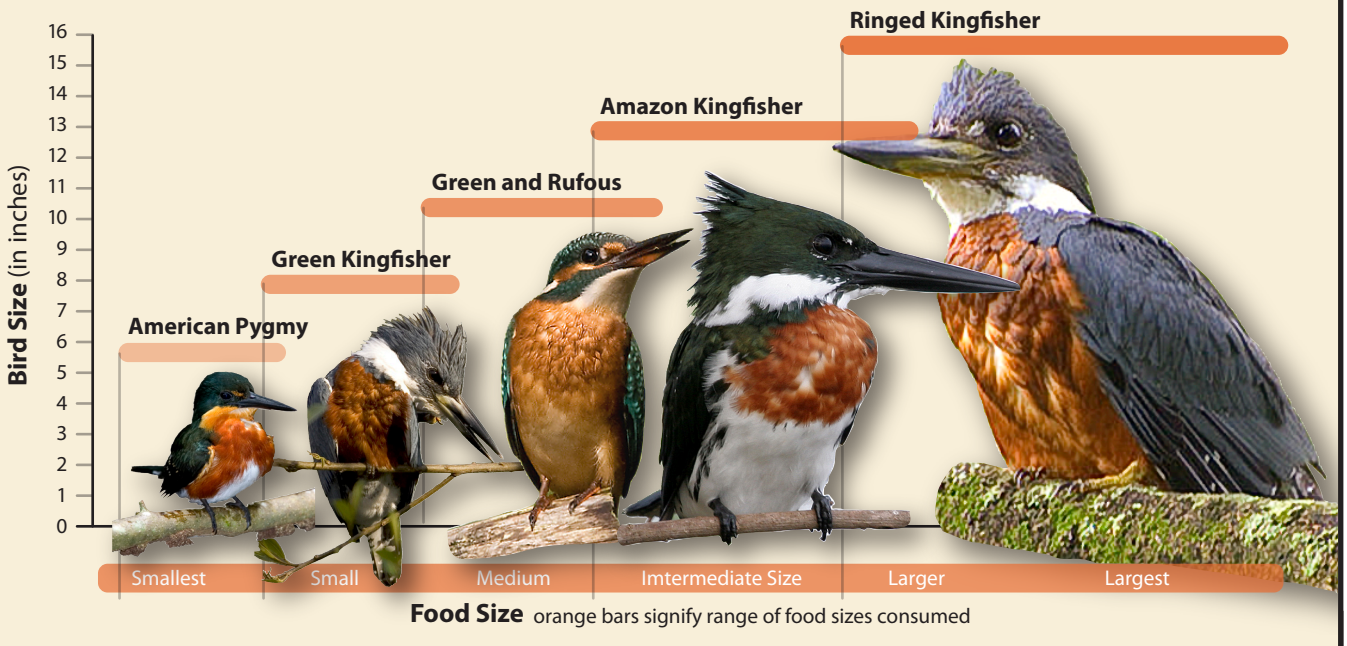
Green and Rufous Kingfisher
Chloroceryle inda

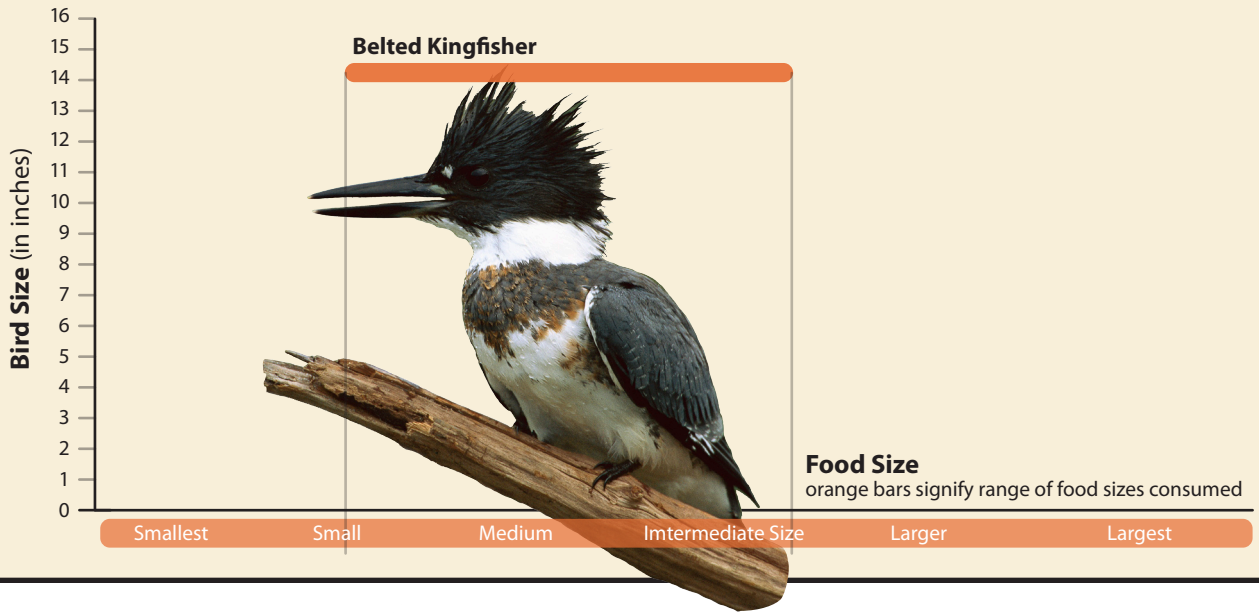
Amazon Kingfisher
Chloroceryle amazona

Ringed Kingfisher
Megaceryle torquata



Kingfishers' Range of Food Supply Consumed





Belted Kingfisher

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